Alternative Perspectives on the Transfer of Learning: History, Issues, and Challenges for Future Research

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A central and enduring goal of education is to provide learning experiences that are useful beyond the specific conditions of initial learning. For example, the design of innovative curricular materials and pedagogical approaches is often aimed at helping students develop robust understandings that will generalize to decision making and problem solving in other situations, both inside and outside the classroom. Other instructional approaches are aimed at improving the chances that later learning is maximized. However, researchers’ progress in understanding and supporting the generalization of learning has been limited due to methodological and theoretical problems with the transfer construct. Numerous critiques of transfer (Beach, 1999; Evans, 1998; Greeno, 1997; Laboratory of Comparative Human Cognition, 1983; Lave, 1988; Packer, 2001; Tuomi-Gröhn & Engeström, 2003) have contributed to a growing acknowledgment that “there is little agreement in the scholarly community about the nature of transfer, the extent to which it occurs, and the nature of its underlying mechanisms” (Barnett & Ceci, 2002, p. 612).

Carraher and Schliemann (2002) advocated abandoning transfer as a research construct because of the deep association of transfer with what they considered a fundamentally flawed transportation metaphor—the passive “carrying over” (p. 19) of knowledge from one situation to another once learners recognized the simi-
larity between situations. Specifically, they contended that the following transfer
dilemma had arisen: If one rejects the idea of transfer on the grounds that it is seri-
ously misconceived, then the notion that new learning is constructed from previous
learning seems to be denied; if one accepts transfer, then questionable beliefs
about knowledge seemed to be endorsed, particularly with respect to the ways in
which abstraction, knowledge, and context are conceived. Other researchers side-
stepped the apparent transfer dilemma by adopting a view that learning and trans-
fer are conceptually indistinguishable, thus negating the need to devote special at-
tention to transfer (e.g., Campione, Shapiro, & Brown, 1995).

In contrast, several alternative approaches to transfer have emerged in response to
the critiques of transfer: (a) transfer as consequential transitions (Beach, 1999,
2003); (b) the affordances and constraints approach (Greeno, 1997; Greeno, Smith,
& Moore, 1993); (c) preparation for future learning (Bransford & Schwartz, 1999;
Schwartz & Martin, 2004); (d) the actor-oriented transfer perspective (Lobato,
2003, in press-a); and (e) several activity theoretic perspectives (Tuomi-Gröhn &
Engeström, 2003; van Oers, 2004). These alternative perspectives have offered a re-
thinking of transfer, including new definitions, metaphors, and methods.

In light of this activity, the National Science Foundation funded two conferences:
The first supported by the Social, Behavioral, and Economic Sciences Directorate
(see Mestre, 2003, 2005), and the second supported by the Education and Human
Resources Directorate (see Lobato, 2004b). Evidence for the endurance and timel-
ness of the transfer issue were also demonstrated in the publication of two edited
books: Between School and Work: New Perspectives on Transfer and Bound-
ary-Crossing (Tuomi-Gröhn & Engeström, 2003) and Transfer of Learning From a
Modern Multidisciplinary Perspective (Mestre, 2005). In his presidential address to
the American Educational Research Association, Schoenfeld (1999) identified
transfer as one of six most basic and pressing arenas in which educational research
needed to make progress in the 21st century. He argued that even if one saw transfer
as a subset of learning, the need for a renewed theory of transfer remained.

In an effort to support productive discussion, debate, and resolution regarding
key issues related to transfer, the Journal of the Learning Sciences (JLS) is spon-
soring a 3-year strand on transfer. This introductory piece to the transfer strand
briefly traces the historical debate regarding the nature of transfer, identifies the
conceptual and empirical progress that has been made by recent alternative per-
spectives on transfer, and presents several research challenges.

THE CONTESTED NATURE OF TRANSFER

The Classical Transfer Perspective

The classical transfer approach refers to the family of common elements theories
that dominated the 20th century, starting with Thorndike’s (1906) identical ele-
ments and more recently the cognitive instantiation of Thorndike’s approach (e.g., see Anderson, Corbett, Koedinger, & Pelletier, 1995). According to Thorndike, transfer occurs to the extent to which original learning and transfer situations share identical elements—typically interpreted as shared features of physical environments or common stimulus elements, especially by later behaviorists (see Cox, 1997, for a more detailed historical account).

With the cognitive revolution, the notion of identical elements was reformulated as mental symbolic representations. That is, people construct symbolic representations of initial learning and transfer situations. Transfer occurs if these two representations are identical, if they overlap, or if a mapping can be constructed that relates features of the two representations (Anderson et al., 1995; Reed, 1993; Sternberg & Frensch, 1993).

Whereas some accounts of the history of transfer distinguish between the environmental theory of Thorndike and more recent cognitive approaches (e.g., see Royer, Mestre, & Dufresne, 2005; Tuomi-Gröhn & Engeström, 2003), others conceive of a historical lineage from associationist to cognitivist perspectives on transfer (e.g., De Corte, 1999). In fact, Singley and Anderson (1989) in their seminal cognitive account of transfer explained that they “resurrected Thorndike’s theory by redefining his identical elements as the units of declarative and procedural knowledge in the ACT* theory” (p. 248). Despite the adaptations—from the brain cell/environmental “mentalism” of Thorndike, to the stimulus elements of the behaviorists, and later to the if-then goals of cognitive production systems—the historical focus on common elements has remained (Cox, 1997). As summarized in a report by the National Research Council, “Transfer between tasks is related to the degree to which they share common elements, although the concept of elements must be defined cognitively” (Bransford, Brown, & Cocking, 2000, p. 78).

Critiques of the Classical Transfer Approach

As with any mainstream thought, there are always challenges to it. In the case of transfer, those were not taken up historically for most of the 20th century. Two of these intellectual challenges merit brief mention. First, more than 100 years ago Höfling (1892) argued for psychological similarity and against similar elements of task features as the basis of transfer, urging that “what matters is how the new situation is connected with the thinker’s trace of a previous situation, which may be quite idiosyncratic” (cited in Pea, 1989, pp. 8–9). Second, Thorndike’s elementalist was questioned by Judd (1908), who proposed that transfer is determined by the extent to which the learner is aware of underlying shared causal principles or deep structure. The preeminence of structural similarity (i.e., meaningful understanding) over common surface features also found a voice among the Gestaltists (e.g., Katona, 1940; Wertheimer, 1945/1959). Although these voices of dissent tended to be isolated, dissatisfaction with the clas-
classical transfer perspective gained momentum in the 1980s and 1990s, when researchers began questioning the conceptualization of transfer by bringing to bear the assumptions about knowing, knower, learning, and context from the theoretical perspective of situated cognition (captured most forcefully in Lave’s 1988 book, *Cognition in Practice*).

The purpose of this article is not to add to the existing critiques of transfer, of which there are many. Rather, this article proposes that differentiating conceptual concerns from other issues (e.g., methods or knowledge organization) can have important consequences for scholarship in this field. I argue, for example, that if conceptual problems are conflated with methodological problems, then it is easy to make minor methodological adjustments without responding to the more serious concerns raised regarding the conceptual roots of transfer. To advance this argument, I first consider five theoretical problems with the classical transfer approach.

First, classical transfer studies privilege the perspective of the observer and rely on models of expert performance, accepting as evidence of transfer only specific correspondences defined a priori as being the “right” mappings (Evans, 1998; Lobato, 2003). Consequently, transfer experiments can become what Lave (1988) called an “unnatural, laboratory game in which the task becomes to get the subject to match the experimenter’s expectations,” rather than an investigation of the “processes employed as people naturally bring their knowledge to bear on novel problems” (p. 20). Second, at the root of the transfer problem is a functionalist view of knowledge in which “the beneficial cognitive consequences of decontextualized learning, freeing oneself from experience” are seen as “a condition for generalization about experience” (Lave, 1988, p. 41). From a situated perspective, the notion of detaching from concrete experience is problematic because knowledge cannot be isolated from practice and meaningfully studied (Brown, Collins, & Duguid, 1988; Hall, 1996; Packer, 2001; van Oers, 1998).

Third, according to critics, transfer researchers often interpret context as the task presented to students and analyze the structure of tasks independently of the students’ purposes and construction of meaning in situations (Carraher & Schliemann, 2002; Cobb & Bowers, 1999; Greeno, 1997). Fourth, the “applying knowledge” metaphor of transfer suggests that knowledge is theoretically separable from the situations in which it is developed or used, rather than a function of activity, social interactions, culture, history, and context. As a result, this view of transfer is severely limited by ignoring the contribution of the environment, artifacts, and other people to the organization and support of the generalization of learning (Beach, 1995, 1999; Guberman & Greenfield, 1991; Laboratory of Comparative Human Cognition, 1983; Lave, 1988; Pea, 1989). Finally, the static nature of the application or transportation metaphor suggests that “the formation of transfer environments are not assumed to be an actual part of the process, but rather are seen as differentially supporting or interfering with it” (Beach, 2003, p. 40). Consequently, the classical transfer approach does not account for the ways in which
people often change transfer situations until they become similar to something they know (Bransford & Schwartz, 1999).

Isolating Concerns With the Conceptualization of Transfer From Issues Regarding Its Occurrence

In addition to the aforementioned problems, the transfer literature has suffered from a paradox regarding its occurrence. On the one hand, obtaining transfer in both laboratory and school-based studies remains largely elusive (Detterman, 1993; Gruber, Law, Mandl, & Renkl, 1996); on the other hand, nearly all learning theories presume that as people learn, they are continually using prior knowledge (Bereiter, 1995; Dewey, 1938; Hatano & Greeno, 1999). A number of researchers have critiqued the classical transfer approach on methodological grounds and have demonstrated greater levels of transfer by (a) moving from one-trial learning situations to ensuring that students have the opportunity to understand a procedure, principle, or theory deeply enough to apply later (Mayer, 1999); (b) shifting from the use of learning transfer tasks that share only structural features to the inclusion of tasks that also share some common surface features (Novick, 1988); and (c) moving away from the use of independent problem solving as a test of transfer to the use of group assessments in which people can utilize resources and gather additional information (Fortus, Krajcik, Dershimer, Marx, & Mamlok-Naaman, 2005).

Others have explained the lack of transfer in research studies by distinguishing types of transfer. Butterfield and Nelson (1991) identified four categories of transfer (within-task, across-tasks, discriminative, and inventive transfer). Perkins and Salomon (1988) distinguished between two forms of transfer (low-road and high-road transfer). Barnett and Ceci (2002) created a taxonomy with nine dimensions, including categories for types of knowledge and types of transfer situations. These category systems have been used to reclassify the transfer literature and demonstrate categories in which transfer is in fact substantial.

Although these organizational and methodological changes have provided important insights into the occurrence of transfer (or, more accurately, the lack thereof), it is also important to note that these adjustments can be adopted without addressing the concerns raised by Lave (1988) and many others regarding the conceptual foundations of transfer. For example, research studies on transfer are still dominated by questions such as the following (see summaries in Bransford et al., 2000; Mestre, 2003): (a) What conditions or factors facilitate transfer? (b) Is transfer hindered by the compartmentalization or contextualization of instruction? and (c) How can education prepare people to recognize the cues that signal application of appropriate knowledge? However, each question suggests that transfer is an unproblematic consensual construct; the only challenge being the facilitation of its occurrence.

The situation is further muddied when conceptual and empirical claims are confused (De Corte, 1999; Packer, 2001). It is easy to conclude from Lave’s (1988)
work that according to the situated cognition perspective, knowledge cannot transfer because it is so strongly embedded in the context in which it is acquired (Anderson, Reder, & Simon, 1996). Greeno (1997) contested this interpretation by responding that Lave’s point was misinterpreted as an empirical one when it was a conceptual one. According to Greeno, Lave’s argument concerned the issue of “how the question of generality and transfer should be formulated, not whether ‘transfer’ occurs” (p. 12). In fact, Lave acknowledged the existence of “continuity of activity across situations” while maintaining that “learning transfer” (as currently constituted) was “not the central source of continuity” (p. 186).

Identifying the Phenomenon Captured by Transfer

Some of the alternative transfer perspectives have emerged not in order to offer an improved approach to the same phenomenon captured by classical measures, but to explore a different (but related) underlying phenomenon. For example, from the classical perspective, transfer is defined as the application of knowledge learned in one context to a new context (Bransford et al., 2000). From the actor-oriented transfer perspective, transfer is defined as the generalization of learning, which can also be understood as the influence of learners’ prior activities on their activity in novel situations (Lobato, 2003, in press-b). These definitions seem similar until one looks more closely at the methods employed in each approach. Although researchers operating from a classical perspective describe transfer as the influence of prior learning experiences on attempts to solve problems in new situations (Marini & Genereux, 1995; Reed, Ernst, & Banerji, 1974), in practice they examine the formation of particular, highly valued generalizations rather than the generalization of learning more broadly (Lobato, in press-b). This is due to both a reliance on expert models of performance and a requirement of correct performance on transfer tasks.

Specifically, researchers operating from a classical transfer perspective typically present participants with a sequence of tasks that share some structural features (e.g., a common solution approach or shared principle) but have different surface forms (e.g., different word problem contexts), according to the researcher’s (or other expert’s) knowledge of the topic. Participants are then taught some solution strategy, principle, or procedure with the initial learning task. If the participants perform better on a transfer task than does a control group (who receives the transfer task but no learning tasks), then positive transfer is said to have occurred. When performance improves, the researcher infers that students have generalized some aspect of the learning experience to the transfer tasks.

In contrast, evidence for transfer from an actor-oriented perspective is found by scrutinizing a given activity for any indication of influence from previous activities and by examining how people appear to construe situations as similar using ethnographic methods, rather than relying upon statistical measures based on improved performance (Lobato, in press-b). This allows for instances of generalizing
to be captured by the actor-oriented transfer approach that would not be counted as transfer in the classical approach (Lobato, in press-a). For example, Lobato and Siebert (2002) performed two analyses on a case study—one from a classical transfer perspective and one from an actor-oriented perspective. Whereas the classical analysis demonstrated failure to transfer the slope formula, the actor-oriented analysis documented substantial ways in which the student’s proportional reasoning in the transfer situation was influenced by learning experiences from a teaching experiment. In sum, transfer from the classical approach is the application from one setting to another of a predetermined set of knowledge from the researcher’s or expert’s point of view; transfer from the actor-oriented perspective is the influence of learners’ prior activities on their activity in novel situations, which entails any of the ways in which learning generalizes.

Understanding which phenomena are investigated by various transfer perspectives involves an analysis of what transfers, the agency of transfer, and the context in which transfer occurs. This point is illustrated by contrasting five transfer approaches:

1. In classical transfer studies, researchers typically use improved performance as a measure of transfer, predetermining “what” will transfer rather than making the “what” an object of investigation.
2. In contrast, diSessa and Wagner (2005) utilized coordination class theory to posit a transfer perspective that depends on careful analysis of an individual’s knowledge, not merely successful or unsuccessful performance.
3. In the situative account offered by Greeno and colleagues (Greeno, 1997; Greeno et al., 1993), both content knowledge and social positioning is emphasized. Transfer is redefined as the extent to which participating in an activity in one situation influences one’s ability to participate in another activity in a different situation. What transfers is not knowledge from task to task but patterns of participation across situations.
4. In Beach’s (1999, 2003) consequential transitions approach, transfer is not taken as the reproduction of something that had been acquired elsewhere; rather it is conceived as a transition involving the transformation of knowledge, skill, and identity across multiple forms of social organization.
5. Whereas Beach focused on developmental trajectories of relationships between individuals and social context, Tuomi-Gröhn and Engelström (2003) focused on developmental trajectories of collective activity in different social organizations. By drawing on activity theory, they treated transfer as the proliferation of collective practices.

By considering a variety of phenomena that can be captured by different conceptualizations of transfer, I am not arguing that one phenomenon is most fruitful for investigation. Instead there are points of tension and compatibility among the
various emerging models of transfer, as well as tradeoffs that each approach makes given the purposes for which each perspective was developed. The point instead is that the historical development of transfer has reached a point in which the “it” underlying an investigation of transfer can no longer be assumed to be a well-agreed-upon construct. Consequently, the growing maturity in the field makes it necessary for researchers to clarify the phenomenon that they are investigating and provide a rationale for how the particular transfer definition and approach that is utilized fits the object of investigation.

**ALTERNATIVE PERSPECTIVES ON TRANSFER: CONTRIBUTIONS AND CHALLENGES**

Although Lave (1988) questioned the conceptualization of transfer in terms of its definition or characterization, she also pointed to a rethinking of transfer along many dimensions. She did this by bringing to bear the assumptions about knowledge, learners, and context from a situated cognition perspective. One goal of the *JLS* transfer strand is to become a new voice for a group that has tried holistically to question transfer from multiple dimensions as opposed to making minor adjustments along a single dimension. In this section, I discuss the progress that has been made rethinking three important dimensions—the metaphor of transfer, conceptions of abstraction, and transfer mechanisms. Additionally, I point to some remaining issues and challenges along the dimensions of abstraction and transfer processes.

**Metaphors**

One point of general agreement across various alternative transfer perspectives has been to replace the static application or transportation metaphor underlying transfer with a dynamic metaphor, such as *production* (Lobato, 2003) or *transformation* (Cobb & Bowers, 1999; Greeno et al., 1993). The classical transfer metaphor suggests that the tasks across which transfer occurs remain unchanged during transfer and that the “transferor” reproduces existing relations between fixed tasks (Beach, 1999; Sfard, 1998). In contrast, numerous researchers have provided evidence that the generalization of learning appears to be a more dynamic process than has been previously understood.

For example, Carraher and Schliemann (2002) demonstrated that engagement with transfer situations can prompt people to reconstruct their understanding of initial learning situations in order to create relations of similarity with the transfer situation. Saxe (1989) characterized transfer in the context of everyday problem solving as a protracted process of repeated constructions of appropriation and specialization rather than as an immediate alignment of prior knowledge to a new functional context. Lobato and Siebert (2002) documented a case study in which a
student demonstrated evidence of transfer only after he appeared to reconstruct his understanding of the relationships among measurable quantities in a complex transfer situation. In each of these cases, the generalizing process involved changing environments and constructing relations rather than reproducing existing relations between unchanged tasks.

In the preparation for future learning approach, Bransford and Schwartz (1999) made the dynamic aspects of transfer a structural part of their reformulation of transfer. As the name suggests, the preparation for future learning approach investigates how people have been prepared to learn to solve novel problems (Schwartz, Bransford, & Sears, 2005). Rather than looking at how people directly apply old knowledge to solve new instances of problems in contexts in which people are deprived of the real world conditions that they would ordinarily exploit (such as soliciting help from colleagues, seeking additional learning resources, and having opportunities to obtain feedback), the preparation for future learning approach demonstrates how the usefulness of prior knowledge may not be apparent until people have been given the opportunity to learn new information (Schwartz & Martin, 2004). In doing so, they document how people often change the transfer situation until it becomes similar to something they know (Bransford & Schwartz, 1999). In a similar effort to capture transfer in learning settings, Rebello et al. (2005) offered a model for documenting “dynamic transfer” as it is constructed in physics teaching interviews. Their model casts transfer as a dynamic phenomenon in which learners construct knowledge in targeted transfer situations.

Abstraction

Responding to critiques related to the roles of abstraction and decontextualization in transfer has been more challenging than tackling issues related to metaphor. In mainstream cognitive accounts of transfer, the formation of sufficiently abstract representations is a necessary condition for transfer (Reed, 1993; Singley & Anderson, 1989). Abstraction is typically conceived as the extraction of commonalities from a set of concrete examples (e.g., Rosch & Mervis, 1975). As a result, it is deemed important for learners to engage with multiple situations and to compare problem solutions in order to construct an abstract representation spanning them (Chen & Daehler, 2000; Gentner, Loewenstein, & Thompson, 2003; Reeves & Weisberg, 1994). Abstraction is thus conceived as a process of decontextualization. According to Fuchs et al. (2003), abstractions “delete details across exemplars … and avoid contextual specificity so they can be applied to other instances or across situations” (p. 294).

As mentioned previously, the notion of detaching from concrete experience is problematic from a situated perspective (Hall, 1996). Hence, many situated researchers reject decontextualization and abstraction as epistemologically incompatible with situativity. In his article The Fallacy of Decontextualization, van Oers (1998) argued that if context is defined via personal interpretation of actions and
events rather than in an absolute and detached way, then the notion of decontextualization seems to suggest “an occurrence of actions in a setting that is not interpreted by the agent. However, that would mean no situation, no action, no meaning at all” (p. 136).

In response, some researchers have suggested that alternative accounts of transfer should forgo theories relying on the constructs of decontextualization and abstraction (Beach, Hundersmarck, & Vassallo, 2003; Engle & Greeno, 2003; Whitson, 2003). However, Cobb (2003, 2004) contended that situated theorists err in dismissing the notion of abstraction because they accept the standard characterization of abstraction as a process of decontextualization at face value. In rejecting abstraction in its standard form, Cobb argued that situated theorists are operating on what Wertsch (2000) might term the semiotic territory of mainstream psychology. Rather than dispensing with the notion of abstraction, Cobb suggested that researchers adapt and develop different views of abstraction.

The following alternative conceptions of abstraction have emerged in an effort to formulate abstraction in a way that is compatible with a situated cognition perspective: (a) situated abstraction, (b) abstraction in context, (c) collective abstraction, and (d) actor-oriented abstraction. The notion of situated abstraction highlights the central role of mediating tools and suggests that artifacts and symbol systems are constitutive of meaning (Hoyle, Noss, & Pozzi, 2001; Noss & Hoyle, 1996). It is by this means that mathematical knowledge can be tied to the ways in which it was learned and used in a sociocultural practice, yet simultaneously be expressed in ways that exhibit invariant mathematical relationships. In the abstraction in context approach, Hershkowitz, Schwarz, and Dreyfus (2001) defined abstraction as the activity of vertically reorganizing previously constructed mathematics into a new mathematical structure within a social practice. By exploring the historical and social dimensions of abstraction, they demonstrated the importance of attending to the multifaceted context in which abstracting occurs.

The notions of collective abstraction (Cobb, 2004) and actor-oriented abstraction (Lobato, 2004a) were presented during a symposium designed to address Cobb’s (2003) challenge to develop different views of abstraction. Cobb (2004) and Lobato (2004a) both developed constructs that involved a rethinking of what is meant by context. In mainstream cognitive accounts of abstraction, context is often treated as the tasks or other features of an experimental situation that are considered to influence the mathematical reasoning evoked. In contrast, Cobb (2004) took context to be the collective classroom norms and practices in which students participate and to whose development they contribute. Lobato (2004a) considered context from the point of view of the actor (learner) rather than as something inherent in the situation that the researcher can manipulate. As a result, contextualizing could be seen as a dynamic process rather than as a static feature of situations to be removed.

In addition, Cobb (2004) and Lobato (2004a) used the notion of reflective abstraction (Piaget, 1977/2001) as a basis for their approaches. In mainstream cogni-
tive accounts, abstraction is typically considered to be an inductive process that occurs when a common property across instances is extracted and encoded in one’s scheme. In contrast, reflective abstraction is a constructive process in which the regularities abstracted by the learner are not inherent in the situation, but rather are a result of personal structuring related to learner’s goals and prior knowledge (Piaget, 1980). Cobb (2004) and Lobato (2004a) both adapted reflective abstraction (which is an individual psychological construct) to consider how aspects of reflective abstraction are structured by the environment. Specifically, Cobb (2004) posited the notion of collective abstraction as the occasions in which the members of a community collectively constitute either prior activity or its results as an explicit object of discourse, and Lobato (2004a) used the notion of attention focusing to connect social and individual levels of analysis.

In addition to these ideas, other themes have been offered for consideration as alternative views of abstraction are developed. Van Oers (2004), drawing upon Cassirer (1923/1953), put forward a view of abstracting as an act of putting objects in a specific context that articulates particular meaning to the objects involved. This view conceives of abstracting as a process of contextualization rather than decontextualization. Nemirovsky (2004) posited the centrality of perceptual activity in the reencountering of past experiences (i.e., transfer). To that end, he rejected the treatment of perception as a passive receptive process but instead treated perception as having active, temporal, bodily, and involuntary qualities.

Although these alternative approaches to abstraction are promising, much work needs to be done. Most are at the stage of theorizing and need instantiation in multiple empirical studies. They need to be situated in corresponding approaches to transfer and utilized to explain transfer events. The JLS would like to support the effort of the field to compare and contrast these constructs in order to consolidate efforts, build upon one another’s contributions, and get better traction on the transfer dilemma.

As new ideas and approaches to transfer develop, we will be in a better position to challenge current views regarding relationships among abstraction, context, and transfer. For example, a report from the National Research Council summarized the prevailing cognitive perspective on transfer: “Knowledge that is overly contextualized can reduce transfer; abstract representations of knowledge can help promote transfer” (Bransford et al., 2000, p. 53).

In a radical reformulation of this generally accepted assumption, diSessa and Wagner (2005) offered an alternative to transfer occurring by virtue of the abstractness of the mental representation, namely that transfer occurs through the accrual and coordination of specific knowledge that is useful in particular situations. According to Wagner (2006), transfer is supported through “the incremental refinement of knowledge resources that account for—rather than overlook—contextual variation” (p. 1). diSessa and Wagner also contended that the link between multiple contexts and transfer cannot be reduced to a numeric argument. In their words,
“… a new context that does not require any new causal net elements or new readout strategies is not helpful,” but a context that “provokes use of a new intuitive idea that extends the range of contexts that are seen as relevant … will likely be productive” (diSessa & Wagner, 2005, 149).

Transfer “Mechanisms”

The alternative models of transfer described previously represent, to a large degree, attempts to create alternative interpretive frameworks. As alternative approaches mature, they need to move toward theory development, which includes tackling the notion of transfer mechanisms. This presents theoretical challenges, because the very notion of mechanism is associated with a particular view of knowledge and causation that may no longer be applicable within an alternative interpretative framework, especially one grounded in a situative or sociocultural perspective.

In classical models, transfer mechanisms are factors that can be controlled in order to produce transfer (De Corte, 1999; Gentner et al., 2003). Van Oers (2004) criticized the classical transfer perspective because it focuses exclusively on the conditions for transfer and defines transfer merely on the basis of result qualities. However, once the conceptual and theoretical roots of transfer are questioned, the notion of a transfer mechanism doesn’t make sense in the same deterministic way. We need a notion of mechanism that refers to an explanation of how social environments afford and constrain the generalization of learning, and thus shifts the focus from external factors that can be controlled to conceiving of transfer as a constrained socially situated phenomenon. To this end, Maxwell’s (2004) notion of process causality is useful.

Maxwell (2004) distinguished between two different but compatible types of causality—regularity causality and process causality. Process causality is based on a conceptual analysis of the processes by which some events can influence others. Specifically, process theory deals with events and the processes that connect them conceptually. In contrast, in the regularity conception, causality cannot be directly observed but can only be measured in the regularity of relationships between events. This necessitates a focus on the determination of a systematic relationship between inputs and outputs across a number of cases. Whereas regularity causation is most useful in establishing that something is happening, process causality addresses why or how.

Drawing on the notion of process causality, Lobato, Ellis, and Muñoz (2003) advanced the notion of focusing phenomena to link features of instructional environments with the particular ways in which individuals generalize their learning experiences (i.e., transfer from an actor-oriented transfer perspective). Focusing phenomena are features of classroom environments that regularly direct students’ attention toward certain (mathematical) properties or patterns when a variety of features compete for students’ attention. They emerge not only through the instructor’s
actions but also through mathematical language, features of the curricular materials, and the use of artifacts (Lobato & Ellis, 2002a, 2002b; Lobato et al., 2003). The resulting mathematical object of focus and what students notice mathematically are co-constituted through focusing phenomena and students’ prior knowledge, experiences, and goals. Although the idiosyncratic forms of transfer often identified through the use of the actor-oriented transfer perspective may at first seem arbitrary, the work on focusing phenomena is demonstrating a basis by which actor-oriented transfer is constrained (Lobato, 2003). For example, informal comparisons among the original study and two follow-up studies indicated that qualitative differences in the nature of individuals’ generalizations corresponded to significant differences in the focusing phenomena that emerged in the different instructional environments (Ellis & Lobato, 2004; Lobato, 2005). The notion of focusing phenomena as a transfer mechanism casts transfer as a constrained socially situated phenomenon rather than as something that can be controlled solely by altering external conditions.

A second transfer “mechanism”—social framing—is offered by Engle (this issue) as part of a promising effort to extend work on a situative approach to transfer by Greeno and colleagues (e.g., Greeno et al., 1993) to the analysis of classroom-based instances of transfer. Engle advances the hypothesis that “transfer is more likely to occur to the extent that learning and transfer contexts have been framed to create what is called intercontextuality between them” (p. 456). When this occurs, the content established during learning is considered germane to problem solving in the transfer context. She demonstrates two kinds of framing that are productive for transfer: (a) framing learning activities as being temporally connected with other settings in which the learning experiences are relevant, and (b) framing students as contributing members of a broader community of people involved in the particular intellectual endeavor. In her article, Engle provides evidence that these forms of framing appear to have encouraged the students to expect that they would be generatively using what they were learning, thus leading them to make better use of the content-based supports for transfer that were available.

Finally, a third transfer process involves the discernment of differences. In a radical reversal of 100 years of transfer research emphasizing the role of similarity of various types (task similarity, scheme similarity, psychological similarity, and similarity in socio-cultural practices), Marton (this issue) elaborates the role of discerning differences in transfer. According to Marton, “transfer is about how what is learned in one situation affects or influences what the learner is capable of doing in another situation” (p. 501). This influence of one activity on another can have as much to do with perceived differences as to perceived similarities. Marton maintains that the critical part of the transfer process is what learners attend to, which is affected by discernible differences as much as similarities. One powerful study presented in the article involves learning Cantonese tones. Spoken Cantonese words are distinguished by both sound and tone. When a foreigner hears a word, he cannot discern sound from tone unless the tone differs significantly from a familiar
intonation pattern. However, if the first word is followed by a second word that has the same sound but a different tone, the foreigner suddenly hears the tone in the second word, and, retrospectively in the first word, because of the contrast. This case constitutes an instance of transfer because hearing the first word influenced what was heard when the second word was spoken. According to Marton, “although the sameness of the sounds across the two words was a necessary condition for discerning the tone, it was the difference—and not the sameness—that was attended to, discerned, and transferred” (p. 531).

As new transfer processes are identified and elaborated, we can challenge current instructional approaches to transfer and develop new ones. For example, it is a widespread belief that “knowledge that is taught in only a single context is less likely to support flexible transfer than knowledge that is taught in multiple contexts” (Bransford et al., 2000, p. 78; see also for a summary of research). However, the work on focusing phenomena suggests that what is critical for the generalization of learning is not the number of contextual situations explored but the particular mathematical regularities and properties to which students’ attention is drawn and that students notice (Lobato, 2005). Engle’s work (this issue) on framing suggests that as educators we need to pay closer attention to the classroom practices that develop around generalizing and to frame learning and transfer activities in such a way to promote intercontextuality. Finally, Marton’s paper (this issue) suggests that the important idea is making systematic use of variation to enhance learning, which could be accomplished within a single context, as long as the variation is centrally related to the object of learning.

THE JLS TRANSFER STRAND

In this article, I have highlighted the conceptual critiques to the classical transfer approach, described the progress that has been made by alternative emerging approaches to transfer, and identified some remaining issues. For the next 3 years, the JLS is interested in receiving empirical and theoretical papers that respond to challenges regarding the conceptualization of transfer and constructively contribute to the ongoing transfer dialogue. It is my hope that we, as a community of researchers, transcend the era of critiquing the classical transfer approach by resolving persistent and thorny issues and by further developing alternative approaches to transfer. Most of the alternative approaches are in their infancy and remain at the level of theoretical writing. Therefore, more work is needed to develop approaches with sufficient specificity to allow for the explanation of instances of transfer in classrooms, as well as in work and everyday settings.

In this issue, Marton and Engle begin this discussion, articulating important new ways to approach the difficult issue of transfer “mechanisms.” The core articles are followed by a commentary by Greeno, who situates the issue in terms of
two critical themes for understanding transfer: (a) authoritative, accountable positioning in interaction; and (b) connected, general knowing in conceptual domains. The JLS encourages others to submit work related to the themes identified in this kickoff issue, as well as to other important dimensions of transfer. Our hope is that the JLS transfer strand will become a new voice for a group that is working toward resolutions that will have the power to influence the ways in which we understand and support the generalization of learning.

ACKNOWLEDGMENTS

This research is supported by the National Science Foundation (NSF) under Grants REC–0529502 and REC–0450208. The views expressed do not necessarily reflect official positions of the NSF.

I am grateful to Anthony E. Kelly for his careful reading and insightful comments on a draft of this article.

REFERENCES


Cobb, P. (2003, April). Discussant comments for the symposium. In K. Beach (Chair), Sociocultural, semiotic, situative, and activity theoretic alternatives to the transfer metaphor: New understandings of how knowledge generalizes. Symposium conducted at the annual meeting of the American Educational Research Association, Chicago, IL.


Engle, R., & Greeno, J. (2003, April). Framing interactions to foster productive learning. In K. Beach (Chair), Sociocultural, semiotic, situative, and activity theoretic alternatives to the transfer metaphor: New understandings of how knowledge generalizes. Symposium conducted at the annual meeting of the American Educational Research Association, Chicago, IL.


Gentner, D., Loewenstein, J., & Thompson, L. (2003). Learning and transfer. *Journal of Educational Psychology, 95*(2), 393–408.


Lobato, J. (2004b). *An international working conference: Addressing the transfer dilemma*. Proposal REC-0450208 funded by the National Science Foundation.


Lobato, J. (in press-a). When students don’t apply the knowledge you think they have, rethink your assumptions about transfer. In C. Rasmussen & M. Carlson (Eds.), *Making the connection: Re-


Whitson, J. (2003, April). Thinking, learning, knowing, doing, and becoming: Semiotic and pragmatic bases for an alternative to “transfer.” In K. Beach (Chair), *Sociocultural, semiotic, situative, and activity theoretic alternatives to the transfer metaphor: New understandings of how knowledge generalizes*. Symposium conducted at the annual meeting of the American Educational Research Association, Chicago, IL.